LIBBY AND HUNGRY HORSE MODELING TECHNICAL ANALYSIS 8346500

SHORT DESCRIPTION:

Evaluate the impacts of drawdowns at Libby and Hungry Horse reservoirs on important game fish in the various parts of their life cycle. Develop/refine IRCs, maintain model code, modify program utilities and run simulations using the Montana reservoir models LRMOD and HRMOD. Construct optimization programs to link IFIM river models with existing reservoir models. Develop and refine experimental flow releases for white sturgeon recovery.

SPONSOR/CONTRACTOR: MDFWP

Montana Fish, Wildlife & Parks

Brian Marotz, Fisheries Program Officer

490 North Meridian, Kalispell, MT 59901

406/751-4546 marotz@digisys.net

SUB-CONTRACTORS:

The modelor previously funded by this project resigned in June 1996. We have not refilled this position and are having trouble finding a qualified replacement. We will likely write a contract modification to use vacancy savings to fund a subcontract. If approved, we will subcontract through competitive bid. We will reveal the successful subcontractor at that time.

GOALS

GENERAL:

Supports a healthy Columbia basin, Maintains biological diversity, Increases run sizes or populations, Provides needed habitat protection, Adaptive management (research or M&E), Inter-agency Coordination

RESIDENT FISH:

Research, M&E

NPPC PROGRAM MEASURE:

10.3A.4, 10.3B.3 and 10.4B.5

RELATION TO MEASURE:

This project partially funds computer programming / modeling needed to keep the quantitative biological models (HRMOD and LRMOD) up to date, and provides model output required for many system-wide applications. These reservoir models were used to develop and modify Integrated Rule Curves for Hungry Horse and Libby Reservoirs (Marotz et al. 1996). These models also result in the development and refinement of the Tiered Flow Approach for recovery of the endangered Kootenai River white sturgeon. The IRCs and Tiered Flows were designed to balance hydropower and flood control with resident and anadromous fish, and their habitat.

BIOLOGICAL OPINION ID:

Work related to white sturgeon recovery

OTHER PLANNING DOCUMENTS:

Hungry Horse Mitigation Plan (Approved by NPPC)Hungry Horse Implementation Plan (Approved by NPPC)Libby Mitigation and Implementation Plan (In Public Review Process, to NPPC this spring)Kootenai White Sturgeon Recovery Plan (Draft)Bull trout Restoration Plans (various states of completion)

TARGET STOCK	LIFE STAGE	MGMT CODE (see below)
Kokanee Kootenai River burbotinterior redband mountain whitefish rainbow trout	All	NN,WS,N,WNN
Westslope cutthroat	All	N,W
Bull trout	All	(P),N,W
Endangered Kootenai River white sturgeon	Entire riverine portion of lifecycle, concentrated on spawning and egg to yearling stage	(L),S,N

AFFECTED STOCK	BENEFIT OR DETRIMENT
Northern squawfish	Detrimental
Pigmy whitefish	Beneficial

BACKGROUND

STREAM AREA AFFECTED

Stream name:
Flathead and Kootenai Rivers

Stream miles affected:
Approximately 363 miles, plus system-wide

Hydro project mitigated:
Hungry Horse and Libby Reservoirs

LAND AREA INFORMATION

Subbasin:
Upper Columbia

Land ownership:
Both

Acres affected:
I do not have a planimeter estimate of the Upper Columbia drainage

Habitat types:
Reservoir and river

HISTORY:

Computer modeling began in 1985 as part of research on Libby and Hungry Horse reservoirs. Empirical data from 1982 to 1987 were used to construct and verify to reservoir components. Additional data from 1988 through present has been used to extend the models downstream and add utilities at the request of operating agencies (BPA, Corps and Bureau of Reclamation). Modeling was funded in part by the SOR process 1991-1995. This project began when the SOR concluded. This project funded our computer modeler and purchase minor hardware and software to continue research on Integrated Rule Curves, white sturgeon and salmon recovery and to link river and reservoir models. During 1996 the tiered flow approach was developed for white sturgeon recovery and was unanimously supported by the recovery team. The ISG stated in their Return to the River document, that the IRCs were consistent with their Normative River Concept and recommended that IRCs be implemented on several other storage reservoirs throughout the Columbia System. Recently, an ISAB representative stated that the IRCs (modeling strategy) represent a valuable tool for balancing Columbia River operations, and should be applied basin-wide. The B.C. Ministry of Environment has also shown interest in applying the technique on Canadian storage projects. The IRC flood control strategy was also analyzed by ACOE and found to be quite similar to their VARQ flood control strategy. This led to slight modifications in the IRCs to accommodate desired results.

BIOLOGICAL RESULTS ACHIEVED:

Integrated Rule Curves were completed in 1994 and published in January 1996. The models provided quantitative results for Libby and Hungry Horse reservoirs that were used to assess resident fish concerns relative to ESA actions on endangered Snake River salmon. Recently, LRMOD was used to develop an experimental design for the tiered approach for flows to enhance endangered Kootenai River white sturgeon spawning and rearing. The IRCs were adopted by NPPC, but have not as yet been implemented because of conflicts with the 1995 NMFS Biological Opinion for Snake River salmon.

The models were also used to evaluate the effectiveness of selective withdrawal for temperature control at Hungry Horse Dam. Results were used during the design of the structure which was built and became functional in August 1985. Flathead River temperatures now mimic the natural thermal regime.

PROJECT REPORTS AND PAPERS:

Model Development to Establish Integrated Operational Rule Curves for Hungry Horse and Libby Reservoirs, Montana. January 1996. Mitigation for Excessive Drawdowns at Hungry Horse and Libby Reservoirs. MFWP and CSKT, 1993. Appendix K SOR EIS portions pertaining to Hungry Horse and Libby. 1996. Aquatic Modeling: Hungry Horse Selective Withdrawal. 1995.

ADAPTIVE MANAGEMENT IMPLICATIONS:

Integrated Rule Curves balance power and flood control with resident and anadromous fish. IRCs contain an independently derived strategy for system flood control (nearly identical to the Corps VARQ strategy). The White Sturgeon Recovery Team voted unanimously to support the tiered approach to sturgeon flows (embodied n the IRC concept). The IRCs are less costly to implement than the NMFS Biological Opinion and provide balance between resident and anadromous fish requirements.

PURPOSE AND METHODS

SPECIFIC MEASUREABLE OBJECTIVES:

To link river IFIM-based models to reservoir models. To provide a framework to compare incremental tradeoffs to resident and anadromous fish caused by various system operating strategies (beyond the SOR process). To create regional equity in system operations to benefit all fish from a system-wide perspective.

CRITICAL UNCERTAINTIES:

Models are constructed to mimic reality using empirical data. Once IRCs are implemented, biological results must be evaluated empirically. The IRCs do not provide summer flows called for by the NMFS Biological Opinion.

BIOLOGICAL NEED:

Computer modeling has been the focus of many system-wide evaluations (SOR process, technical analysis team, NPPC cost evaluations, Al Wright Process, Technical Management Team, White Sturgeon Recovery Team, etc.).

HYPOTHESIS TO BE TESTED:

See 1996 report on models.

ALTERNATIVE APPROACHES:

The NMFS BiOp was assessed and determined to cause poorer reservoir refill than the IRCs, causing negative impacts on reservoir productivity. The BiOp also causes an unnatural second peak in the Flathead and Kootenai Rivers as storage is released to meet summer flow targets downstream. This effect is inconsistent with the Normative River Concept. We are currently assessing a gradual ramp down strategy that normalizes river flows while improving summer flows. This compromise approach was designed to balance white sturgeon requirements with salmon recovery actions and other resident fish.

JUSTIFICATION FOR PLANNING:

N/A

METHODS:

The models are empirically calibrated component models that run using Fortran and Basic. Models can run on a PC with appropriate memory. The modeling strategy is site-specific but the concept is portable to other reservoirs given the necessary physical and biological data. Statistics are typically non-linear regression, multi-variate analyses and empirical relationships. The statistics and model components have been critically reviewed twice by the Fishery Research Institute and Applied Physics Laboratory, Seattle. Targeted fish species include westslope cutthroat at Hungry Horse and kokanee salmon and white sturgeon at Libby. Effects of hydro operations on trophic levels can be used to qualitatively assess non-targeted resident fish species (including bull trout, whitefish, rainbow and various non-game species).
The models require updating as new empirical evidence becomes available. A model specialist is needed to program improvements and to provide model results for various requests by BPA and other agencies. The modelor may be a Department employee or subcontractor.
The IRCs can be implemented by incorporating algorithms into existing system models, or we could develop a simplified model to be used by dam operators.

PLANNED ACTIVITIES

SCHEDULE:

Planning Phase	**Start** Jan. 1997	**End** when implemented	**Subcontractor** Open

Task During 1997, modeling will focus on white sturgeon and system analyses assessing resident and anadromous species (the models can be used with other system models HYDROSIM and HYSSR. Flood control aspects may require adjustment when the ACOE completes their report on the subject.

Implementation Phase	**Start** ?	**End** ?	**Subcontractor** None

Task Depends on scientific and policy decision making

CONSTRAINTS OR FACTORS THAT MAY CAUSE SCHEDULE OR BUDGET CHANGES:
Implementing model products (IRCs) will influence power, flood control and target flows for anadromous species recovery. Timing of implementation is dependent on adoption of VARQ by ACOE, and scientific and policy decision making.

OUTCOMES, MONITORING AND EVALUATION

SUMMARY OF EXPECTED OUTCOMES

Expected performance of target population or quality change in land area affected:
The goal is to achieve watershed equity and a balanced system-wide ecosystem approach to Columbia River operations. Focus is on multiple species. The models will provide results to operating agencies. Future links between river and reservoir models will further refine assessments of tradeoffs between reservoir and riverine fish requirements.

Present utilization and convservation potential of target population or area:
Multiple use. Headwaters remain relatively pristine and contain functioning ecosystems and species diversity that can be used as a source for repairing past damages in other areas. Today, man's activities have effected nearly all areas that are not too high, steep, wet or dry, cold or hot to develop. Pristine (wild) ecosystems have become fractionated and isolated, and as such become unstable and vulnerable to cataclysmic events (e.g. fire, flood, pollution etc.). In many areas, there is no longer a nearby reserve of a like ecotype that can protect or restock an area after a cataclysm. This makes the remaining pristine areas more valuable than ever before as living laboratories and reserves of species diversity. Hungry Horse Reservoir and upper south fork Flathead River contains an intact native species assemblage, including one of the strongest remaining populations of westslope cutthroat and bull trout. Libby Reservoir and upper Kootenai in British Columbia contains what may be the most viable metapopulations of bull trout in existance. Both drainages are inhabited by grizzly bear, mountain goats, bighorn sheep, bald eagles and many endangered plants. These areas must be recognized for their scientific and biological value. Potential is high.

Assumed historic status of utilization and conservation potential:
Unlimited supply, frontier ethic.

Long term expected utilization and conservation potential for target population or habitat:
Protect what is left. Use as source to repair other damaged areas.

Contribution toward long-term goal:
Better model to predict the future operations effect. This technique, if applied to all storage projects, will form the headwaters component(s) of an expert management program for the Columbia River system. Wet subbasins can provide a naturalized hydrograph (within flood control criteria) for anadromous species recovery, while dry subbasins a spared to protect important resident fish. Models can be used to assess tradeoffs between species or areas when plans conflict.

Indirect biological or environmental changes:
Normalized river flows can restore natural flood plain function. Terrestrial species will benefit as well as aquatic organisms.

Physical products:
The models themselves.

Environmental attributes affected by the project:
Reservoir elevations, river flows, discharge temperatures.

Changes assumed or expected for affected environmental attributes:
Improved biological production and increased fish growth potential in the reservoirs and rivers.

Measure of attribute changes:

Restoration of flushing flows in regulated river reaches will depend on allowable river stages and the physical capacity of the dam. Given this, substrate armoring can only be partially offset by higher flows during the spring freshet.

Assessment of effects on project outcomes of critical uncertainty:

Population monitoring, sampling of primary production using C14 scintillation, chlor a, zooplankton density and vertical distribution, benthic insect grabs, fish food habits, growth rate evaluation (scale and otolith), migrant trapping, riparian revegetation evaluation, hydrographic monitoring.

Information products:

Models produce graphic and tabular representations of inflow, reservoir surface elevation, discharge, withdrawal depth, discharge temperature, reservoir thermal structure, isopleth diagrams, daily themographs, thermal unit summaries, carbon fixation by phytoplankton, phytoplankton washout, zooplankton production and washout by genera, benthic insect production, terrestrial insect deposition by order, monthly growth of target fish species in the reservoir by length and weight (westslope cutthroat and kokanee), discharge temperature and fish growth potential in the river. The models also provide hydrologic data at points downstream (H. Horse: Flathead Lake elevation and Kerr Dam discharge; Libby: Bonners Ferry flow for white sturgeon, Kootenay Lake elevation and inflow, Duncan Reservoir elevation and discharge, Corra Linn Dam discharge and IJC Treaty limits.

MONITORING APPROACH

The models are empirically calibrated component models that run using Fortran and Basic. First the models should be translated into the language C to keep up with modern techniques.
Once the IRCs are implemented, the biological effectiveness should be evaluated. Monitoring should begin at a low level immediately and a full scale evaluation should begin after five operating years. At that time, a three year monitoring / sampling program should be sufficient to detect measurable effects. Sampling should target westslope cutthroat at Hungry Horse and kokanee salmon and white sturgeon at Libby. The effectiveness of IRC operations on trophic levels can be quantitatively assessed using the same sampling strategy that was used to develop the models. Resident fish species that were not modeled (including bull trout, whitefish, rainbow and various non-game species), can be assessed using spawning surveys, hydroacoustics and netting. Reservoir revegetation projects will require a short-term assessment approximately every five years.
The region should focus experiments on the effectiveness of summer flow augmentation relative to impacts at storage reservoirs. Rather than risking impacts to native resident fish as suggested by the NMFS Biological Opinion to achieve summer flow targets, the region should adopt a compromise operation (IRCs with gradual ramp down from the spring peak). August flows can be safely augmented without causing unnatural flow fluctuation below headwater projects, nor extreme reservoir drafts. Research focused on this issue will allow for informed assessment of tradeoffs when more empirical evidence is available in the future.

Provisions to monitor population status or habitat quality:

Sixteen years of basin-wide bull trout redd counts and juvenile population monitoring in selected index streams. Over twenty years of netting surveys. Spawning population monitoring over 12 years. Ten years of trophic level inventories. River insect inventories, duplicated on approx. ten year intervals at both projects. Long-term thermal monitoring before and since selective withdrawal was installed on Hungry Horse Dam. (see MFWP project reports)

Data analysis and evaluation:

In most cases, direct comparison of pre- and post-treatment. The models are a useful tool as well.

Information feed back to management decisions:

Adaptive management will guide future direction. Things that produce measurable results will continue, things that do not work will be modified or discontinued.

Critical uncertainties affecting project's outcomes:

The main issue here is when the IRCs will be implemented. Scientific review has taken place and concurred with this approach. Yet, policy direction has not allowed any deviation from the NMFS Biological Opinion. We are constantly assured that the BiOp is "a living document" with flexibility to change as new information becomes available, but no change in implementation has occurred. ESA actions must be based on the best available science. Policy makers should assure this occurs. I believe "any corollary" has been addressed previously in this document.

EVALUATION

(See above)

Incorporating new information regarding uncertainties:

Our track record has shown that we readily accept and adapt to new information. Scientific principal leads us to search for the truth. If we are wrong we admit it and gratefully accept the correction, this makes our product better.

Increasing public awareness of F&W activities:

Montana has adopted the IRCs as the states position on reservoir operation. This occurred because of grass roots support for balanced operation. We report to the media that this is a BPA funded project, and the media generally mentions that this is part of a larger effort.

RELATIONSHIPS

RELATED BPA PROJECT	RELATIONSHIP
8346700 Kootenai IFIMZ/Mitigation. Projects 9101901 Hungry Horse Mitigation and 9502500 Flathead IFIM. 9502600 Montana Model Watershed. 9500400 Libby Mitigation Planning. Monitoring will be performed under project 9501200 after IRCs are impleme	Provide Modeling Support, other projects provide data needed for model refinement

RELATED NON-BPA PROJECT	RELATIONSHIP
Kootenai River Ecosystem Improvements Study--KTOI	Cooperative Modeling
White sturgeon Productivity Status and Habitat Requirements--KTOI	Cooperative Modeling of Kootenai River

OPPORTUNITIES FOR COOPERATION:

Modeling efforts have demonstrated cooperative opportunities between NPPC, BPA, BOR, Army Corps, USFWS, State and Tribes and NMFS.

COSTS AND FTE

1997 Planned: $33,460

FUTURE FUNDING NEEDS:

FY	$ NEED	% PLAN	% IMPLEMENT	% O AND M
1998	$25,000			100%
1999	$37,000			100%
2000	$40,000			100%
2001	$40,000			100%
2002	$45,000			100%

PAST OBLIGATIONS (incl. 1997 if done):

FY	OBLIGATED
1983	$132,532
1984	$318,265
1985	$258,174
1986	$416,714
1988	$562,331
1990	$223,140
1991	$230,187
1992	$289,963
1993	$27,501
1994	$28,801
1995	$10,815
1996	$29,872

TOTAL: $2,528,295

Note: Data are past obligations, or amounts committed by year, not amounts billed. Does not include data for related projects.

LONGER TERM COSTS:
I can not predict the future of this modeling effort. If the results are implemented and the work is absorbed by another program or determined to be complete or obsolete, I'm happy to be out from under this task. When will HYDROSIM, SAM and HYSSR be complete?

1997 OVERHEAD PERCENT: Approximately 18.3%

HOW DOES PERCENTAGE APPLY TO DIRECT COSTS:
total minus equipment

SUBCONTRACTOR FTE: 0 so far. Could go to 0.5-1.0 if we must subcontract (see above).

SUPPLEMENTAL RESIDENT FISH EVALUATION FACTORS:
This project is just one aspect of a larger effort